

花铃期土壤干旱影响棉仁油分、蛋白质形成的生理机理

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摘要:棉花是集“纤维、油脂、蛋白质”为一体的重要的经济作物,关于干旱胁迫影响棉花纤维发育的研究较多,而其对棉籽产量和品质形成的报道较少。本研究以德夏棉 1 号和豫早棉 9110 为材料,进行花铃期土壤水分管理[土壤相对含水量 SRWC:75%±5%(适宜含水量,CK);60%±5%;45%±5%]盆栽试验,研究干旱对棉籽品质形成的影响。结果表明:SRWC 60%±5%对棉仁不饱和脂肪酸(UFA)含量的影响较小,SRWC 45%±5%显著降低了 UFA 含量及脂肪酸不饱和指数(UI);SRWC 45%±5%还显著提高了饱和脂肪酸(SFA)含量,最终导致脂肪酸营养品质指标致动脉粥样硬化指数(AI)显著增加、健康促进指数(HPI)显著降低,使脂肪酸营养品质下降。干旱对棉仁非必需氨基酸(NAA)、必需氨基酸(EAA)、总氨基酸(TAA)含量的影响较小,显著增加了脯氨酸含量,降低了赖氨酸含量,但氨基酸主要营养品质指标必需氨基酸指数(EAAI)、营养指数(NI)、蛋白质效率(PER)的变化均较小,说明干旱对棉仁氨基酸含量的影响较小。干旱下,棉仁油分合成关键基因磷酸烯醇式丙酮酸羧化酶基因(*GhPEPC1*)、二酰甘油酰基转移酶基因(*GhDGAT*)表达显著下调,PEPCase、DGAT 活性降低,抑制了脂肪酸合成前体乙酰辅酶 A 和三酰甘油的产生,显著降低了油分累积速率和累积量,因此油分含量降低;干旱下,棉仁蛋白质合成关键基因谷氨酰胺合成酶基因(*GhGS*)、谷氨酸合酶基因(*GhGOGAT*)表达显著上调,GS、GOGAT 活性增加,有利于谷氨酰胺和谷氨酸的生成及蛋白质合成,而且干旱促进了棉株 ¹⁵N 向棉仁的分配,显著增加了蛋白质累积速率和累积量,因此蛋白质含量增加。
关键词:干旱;棉花;棉籽;脂肪代谢;蛋白质代谢

Effects of soil drought during the flowering and boll formation on quality formation of oil and protein in cottonseed kernel

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Abstract: Cotton is an important cash crop, producing fiber, oil and protein. There are many studies to analyze the effect of drought stress on cotton fiber development, but few reports on its effects on cotton seed yield and quality formation. In this study, Dexiamian 1 and Yuzaomian 9110 were selected as experimental materials to perform the soil moisture experiment with three settings of soil relative water content (SRWC), including 75% ± 5% (suitable moisture content, CK), 60% ± 5%, and 45% ± 5%, to study the effects of drought on the formation of oil and protein in cottonseed kernel. Results showed that SRWC 60% ± 5% had little effect on unsaturated fatty acids (UFA) content in cotton kernels, while SRWC 45% ± 5%, significantly reduced the UFA content and the fatty acid unsaturation index (UI), and SRWC 45% ± 5%, also significantly increased the saturated fatty acids (SFA) content. Based on the changes in UFA and SFA, atherogenicity index (AI) was increased and health-promoting index (HPI) was decreased, which resulted in the decline of the nutritional quality of fatty acids. The contents of non-essential amino acids

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(NAA), essential amino acids (EAA), and total amino acids (TAA) in cottonseed kernels were lower under drought than that of CK. In addition, a significant increase in proline content and a decrease in lysine content were detected. The main nutritional indexes of amino acids, essential amino acid index (EAAI), nutritional index (NI), and protein efficiency ratio (PER) showed little difference between drought treatment and CK, indicating that drought had little effect on the amino acids content of cottonseed kernel. Moreover, the expression of phosphoenolpyruvate carboxylase gene (*GhPEPC1*) and diacylglycerol acyltransferase gene (*GhDGAT*) and activities of PEPCase and DGAT were significantly down-regulated, which inhibited the production of fatty acid synthesis precursor acetyl-CoA and triacylglycerol, reducing the oil accumulation rate and the accumulated quantity of oil which reduced the oil content. The expression of glutamine synthase gene (*GhGS*) and glutamate synthase gene (*GhGOGAT*) and the activities of GS and GOGAT were up-regulated, which was beneficial to the production of glutamine and glutamic acid which promoted accumulation rate and accumulated quantity of protein content. Moreover, drought increased the proportion of ^{15}N in cottonseed kernels among cotton plants, which eventually increased ^{15}N content in cottonseed kernels, and increased protein content under drought.

Keywords: drought; cotton (*Gossypium hirsutum* L.); cotton seed; fat metabolism; protein metabolism